

What is claimed is:

1. A laminate structure, comprising:
a first layer having:

a first portion of a non-metallic material, the first portion at least partially
5 encompassing a cutout region; and

a second portion of a metallic material formed within the cutout region,
the second portion abutting the first portion.

2. The laminate structure of Claim 1, wherein the first portion includes a fiber-reinforced polymeric material.

3. The laminate structure of Claim 1, wherein the first portion includes a fiber-reinforced polymeric material having one or more fibers formed from a material selected from a group consisting of aramids, polyolefins, glass, carbon, boron, and ceramics.

4. The laminate structure of Claim 1, wherein the metallic material of the second portion is formed from a material selected from a group consisting of titanium, aluminum, alloys of titanium, alloys of aluminum, and alloys of iron.

5. The laminate structure of Claim 1, wherein the first portion includes a resin.

6. The laminate structure of Claim 1, further comprising a second layer adjacent the first layer, the second layer being formed from a polymeric material.

7. The laminate structure of Claim 6, further comprising an adhesive resin disposed between the first layer and the second layer.

8. The laminate structure of Claim 6, further comprising a third layer having a first portion of a non-metallic material, the first portion at least partially encompassing a cutout region, and a second portion of a metallic material formed within the cutout region, the second portion being co-planar with the first portion, and wherein the second layer is disposed between the first and third layers.

9. The laminate structure of Claim 8, wherein the first portions of the first and third layers are non-coextensive.



25315

PATENT TRADEMARK OFFICE

10. A laminate structure comprising:

a metal-polymer lamina, the metal-polymer lamina having a first face and a second face spaced apart from the first face, extending to a terminal edge, the lamina including:

a ply of fiber-reinforced polymer extending between the first face and the second face and having at least one interior edge, the interior edge defining at least one cutout; and

a ply of metal foil extending between the first face and the second face substantially from the interior edge to fill the at least one cutout.

11. The laminate structure of Claim 10, wherein the metal-polymer lamina further includes a periphery and the terminal edge further defines the at least one cutout abutting the periphery.

12. The laminate structure of Claim 10, wherein the metal-polymer lamina further includes an interior, the interior edge defining the at least one cutout within the interior.

13. The laminate structure of Claim 10, wherein the fiber-reinforced polymer includes a fiber selected from a group consisting of aramids, polyolefins, glass, carbon, boron, and ceramics.

14. The laminate structure of Claim 10, wherein the metal foil includes a metal selected from a group consisting of titanium, aluminum, alloys of titanium, alloys of aluminum, and alloys of iron.

15. The laminate structure of Claim 14, wherein the alloys of titanium are selected from a group consisting of (Ti-6Al-4V), (Ti-15V-3Cr-3Sn-3Al) and (Ti-15Mo-3Al-3Nb).

16. The laminate structure of Claim 10, wherein the polymer includes a resin.

17. The laminate structure of Claim 10, wherein the laminate structure further comprises an adhesive resin.

18. The laminate structure of Claim 10, wherein the laminate structure further comprises a polymer lamina adjacent the metal-polymer lamina, the polymer lamina having a third face and a fourth face spaced apart from the third face, the polymer lamina including:
- 5 a ply of fiber-reinforced polymer extending between the third face and the fourth face extending substantially to the terminal edge.
19. The laminate structure of Claim 18, wherein the laminate structure further comprises an adhesive resin interposed between the metal-polymer lamina and the polymer lamina to adhesively fuse the metal-polymer lamina to the polymer lamina.
- 10 20. The laminate structure of Claim 10, wherein the metal polymer lamina is a first metal-polymer lamina, the laminate structure further comprising a second metal-polymer lamina coupled to the first metal-polymer lamina.
21. The laminate structure of Claim 21, wherein the laminate structure further comprises the adhesive resin interposed between the first metal-polymer lamina and
- 15 the second metal-polymer lamina to adhesively fuse the first metal-polymer lamina to the second metal-polymer lamina.
22. The laminate structure of Claim 21, wherein the first metal-polymer lamina has a first interior edge and the second metal-polymer lamina has a second interior edge and the first interior edge is not co-terminous with the second interior edge.
- 20 23. The laminate structure of Claim 10, wherein the laminate structure further comprises the metal-polymer lamina and metal foil lamina, the metal foil lamina having a fifth face and a sixth face spaced apart from the fifth face and including:
- a ply of metal foil extending between the fifth face and the sixth face.
24. The laminate structure of Claim 23, wherein the laminate structure further
- 25 comprises the adhesive resin uniformly interposed between the metal-polymer lamina and the metal lamina to adhesively fuse the metal-polymer lamina to the metal lamina.
25. A method of laying up a laminate structure, the method comprising:
- impregnating a ply of fiber with a first resin;
- 30 impregnating a ply of metal foil with a second resin;



25315

PATENT TRADEMARK OFFICE

laying up an interrupted lamina of the ply of fiber, the interrupted layer having a terminal edge and being interrupted by the presence at least one cutout defined in the lamina; and

laying up the ply of metal foil to substantially fill the cutouts defined in the interrupted lamina.

5

26. The method of Claim 25, wherein the ply of fiber includes a fiber selected from a group consisting of aramids, polyolefins, glass, carbon, boron, and ceramics.

10

27. The method of Claim 16, wherein the ply of metal foil includes a metal selected from a group consisting of alloys of titanium, alloys of aluminum, and alloys of iron.

28. The method of Claim 18, wherein the alloys of titanium are selected from a group consisting of (Ti-6Al-4V), (Ti-15V-3Cr-3Sn-3Al) and (Ti-15Mo-3Al-3Nb).

15

29. The method of Claim 16, wherein the first resin is a resin selected from a group consisting of thermosetting resin, a thermoplastic resin, and a hybrid polymer resin with qualities of both resins.

30. The method of Claim 16, wherein the second resin is a resin selected from a group consisting of thermosetting resin, a thermoplastic resin, and a hybrid polymer resin with qualities of both resins.

20

31. The method of Claim 16, further comprising:
laying up a ply of the fiber-reinforced polymer to form a second lamina.

32. The method of Claim 22, further comprising disposing an adhesive resin between the interrupted lamina and the second lamina to adhesively fuse the interrupted lamina to the second lamina.

25

33. The method of Claim 16, further comprising:
laying up a ply of the metal foil to form a third lamina.

34. The method of Claim 24, further comprising forming an adhesive resin between the interrupted lamina and the third lamina to adhesively fuse the interrupted lamina to the third lamina.

35. The method of Claim 16, further comprising:

laying up a second interrupted lamina of the ply of fiber, the second interrupted lamina being interrupted by the presence at least one second cutout defined in the second interrupted lamina; and

5 laying up the ply of metal foil to substantially fill the second cutouts defined in the lamina.

36. The method of Claim 26, further comprising spreading an adhesive resin uniformly interposed between the interrupted lamina and the second interrupted lamina to adhesively fuse the interrupted lamina to the second interrupted lamina.

10 37. The method of Claim 27, wherein the cutout and the second cutout are not coterminous.

38. A laminate structure comprising:

a metal-polymer lamina, the metal-polymer lamina having a first face and a second face spaced apart from the first face, extending to a terminal edge, the lamina including:

15

a ply of fiber-reinforced polymer extending between the first face and the second face and having an interior edge, the interior edge defining at least one cutout; and

a ply of metal foil extending between the first face and the second face substantially from the interior edge to fill the at least one cutout;

20

a fiber-reinforced polymer lamina, the polymer lamina having a third face and a fourth face spaced apart, extending to the terminal edge, the lamina including:

a ply of fiber-reinforced polymer extending substantially to the terminal edge; and

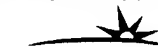
25

an adhesive resin uniformly interposed between the metal-polymer lamina and the fiber-reinforced polymer lamina to adhesively fuse the metal-polymer lamina to the fiber-reinforced polymer lamina.



25315

PATENT TRADEMARK OFFICE



39. The laminate structure of Claim 29, wherein the metal-polymer lamina further includes a periphery and the terminal edge further defines the at least one cutout abutting the periphery.
- 5 40. The laminate structure of Claim 29, wherein the metal-polymer lamina further includes an interior, the interior edge defining the at least one cutout within the interior.
41. The laminate structure of Claim 29, wherein the fiber-reinforced polymer includes a fiber selected from a group consisting of aramids, polyolefins, glass, carbon, boron, and ceramics.
- 10 42. The laminate structure of Claim 29, wherein the metal foil includes a metal selected from a group consisting of titanium, aluminum, alloys of titanium, alloys of aluminum, and alloys of iron.
43. The laminate structure of Claim 33, wherein the alloys of titanium include (Ti-6Al-4V), (Ti-15V-3Cr-3Sn-3Al) and (Ti-15Mo-3Al-3Nb).
- 15 44. The laminate structure of Claim 29, wherein the polymer includes a resin.



25315

PATENT TRADEMARK OFFICE